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ABSTRACT

This paper describes the future perspectives of biocybernetic communication research applied to television, i.e., the measurement of the information impact of television on both individual human beings and groups in terms of energetic changes in the human body. A summary of the recent state of the art of biocybernetic research includes discussions of new developments and the future of this field in respect to communication processes and media production research. In particular, the promising new technologies of biotelemetry, computer tomography of the brain (CAT scans), chemospectrography, and magnetometry of the brain are discussed in the context of the methodologies of existing testing laboratories and preview houses. A summary of the implications of such research for the production of television programs, directions of future research in this area, and computer applications in the processing of data conclude this paper. A 41-item bibliography is provided. (MES)

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# FUTURE PERSPECTIVES OF BIOCYBERNETIC RESEARCH IN TELEVISION

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## ABSTRACT

Biocybernetic communication research deals with the information impact of a film or television show, photographic picture, painting, exhibition, display, any literary, functional texts or verbal stimuli on human beings, both individuals as well as on groups (mass audience).

The research strategy consists of a series of specific tests - sondages performed by the psychophysiological instrumentation on live persons who receive the media information input.

The information processing, perception and storages within the human world are seen as an *energetic process with catalytic characteristics.* Therefore, what we measure in biometric research are the energetic changes in the human body due to the information impact from films, television, radio programs, or generally due to the perception of our informational environment.

The disciplines or fields, which substantially help or clarify the subject are; information and systems theories, cybernetics, neurology, neurophysiology and neuropsychology.

This paper describes the future perspectives of biocybernetic communication research applied to television. A summary of the recent state of the art of biocybernetic research is given, discussing new developments and the future of this field in respect to communication processes and media production research. In particular the promising new technologies of biotelemetry, computer tomography of the brain, (CAT scans), chemospectrography and megnetometry of the brain are discussed.

These recent discoveries and advances in biocybernetic television research are discussed in the context of the methodologies of existing testing laboratories and preview houses. Implications for the production of television programs, future directions of research in this area, and computer applications in the processing of data are also included.

## 1. INTRODUCTION

Biocybernetic research in television is a relatively new field. Thirty years ago saw the beginning of the first measurements of the information impact of television programs with very bulky and marginally sensitive electrophysiological instrumentation. Ing. Sallesi Lavergne is credited with the establishment of the first biometric laboratory in Belgium, in the years 1952 through 1958, where research was centered on the information impact measurement of film and television programs. He employed a combination of psychological and physiological measurements. The indirect observation and conditioning (via infrared photography) was combined with GSR and ESR response registration.

During the same time, two other biometric laboratories were built in Czechoslovakia and Russia. At Purkinje Physiological Institute in Prague, a five channel biometric laboratory was in operation aimed at the measurement of responses from the psychical impact of exhibitions, museums, galleries and various propogandistic materials. The results of this endeavour later led to the development of varied exhibition styles such as Polyecran, Laterna Magica or Kinoautomat. From 1958, film and television programs were also regularly tested.

In the Soviet Union, Prof. Yarbus started experimentation with physiological measurements of audiences in 1952, and perfected the electroretinographic instrumentation and methodology to a great extent. The major part of the work was carried out in Moscow during the '50's and '60's, but the laboratory ceased its activity after 1967. Mosfilm and Moskauer television studios were employing biometric testing during the years 1962-1964.

In Japan, Prof. Yagi started his experimentation with multichannel biometry in the early '60's and developed a very sophisticated biometric laboratory at Nihon University in Tokyo. The Japanese contributed greatly to the miniaturization of biometric scanning equipment and to the indirect increase of electrode sensitivity (amplifiers). The NHK television network had done some biometric research applied to television during the early 1970's.

A major breakthrough was presented in 1965 with the invention of the distant electrode scanner (Harrison, England) and a very sensitive barium lythium electrode, although practical use was hampered by a high level of noise present within the scanned signal.

In the USA, the long tradition of electrophysiological response research dating from 1921 (McCall, Greene, Laskin) was first enhanced during the '30's when experiments of a biometric nature were taking place in Bloomington, Indiana (Gilbert, Morse, and Dunn), in Baltimore (Bailey, Miller), and in Rochester (Minn). The second major advance occurred here during the '50's (Haber, Stark, Atkinson, Hubel, Campbell, Thiel) with specialized recording of various biometric channels. During the '60's, the first spectral analysis of EEG was performed by Zeitlin, Gevins and J. P. Spire and similar work was carried out in the analysis of auditory and visual stimuli by Stacy, Lear, Griffin and Oliver.

Television networks in the United States were relatively slow in the application of biometric testing strategies. CBS carried out their first experimentation with psychophysical tesing during the 1960's and 1970's, but afterward they steered the audience research methodologies towards a digital, numerical approach. ABC and NBC had tried, unsuccessfully, to apply biometric research and then sucumbed to the pressure of quantative ratings praxis of the Neilsen, BBM and Arbitron systems.

In Canada, the first biometric testing of television programs began in 1967. In September of that year the idea for a communication research laboratory was conceived in the Department of Communication Arts at Loyola College, in order to examine the effects of mass media information stimuli, like film and television programs, photographs, etc., in a scientific way.

Through a private grant from Fleetwood Industries, in 1968, an eye movement detector, an infra-red oculograph Eye-Mark I, was purchased. At that time, it was the first such installation in Canada for the purposes of mass audience impact measurements.

In 1972, the laboratory received a major grant, $78,000, to construct a multi-media research lab, with modern biometric equipment.

During the period of 1973-1976, the methodology of biometric audience response measurement was demonstrated at two national and eight regional seminars for the Canadian Broadcasting Corporation. More than 400 producers, designers and programming executives attended these seminars. Radio-Canada, the french division of CBC, published the proceedings of the seminars under the title "Information Design". After our example in Canada, laboratories for audience response measurements were established in the United States, Europe, Australia and Japan.

In 1979, the biometric laboratory was completed with an X-Y plotter and a portable visual detector camera. Both these pieces of equipment, gave the testing unit, versatility and portability. Within the next two years, 76 projects were completed with a location component in them. In 1981, the first telemetric system was installed enabling biometric data to be transmitted over distances to the laboratory. In 1983, the addition of a new datagraph for multi-channel electroencephalographic recordings, and increased electrode capability was added to this facility.

At the present time, biocybernetic research in television is applied on several levels:

### 1.1 Audience Research

In this area of research fall studies that monitor physiological responses such as eye movement, oculographic and electroretinographic response registrations. The other channels that are employed here are GSR, EKG and EEG measurements of primary audience responses through direct observation, on-line, in real time up to 40 seconds after a program is screened. The methodology seeks to gather data on human information perception using actual audience samples in order to learn more about the impact of a television program.

### 1.2 Program Development Research

Studies relevant to the television image and sound design fall into the area of program development. Here, researchers study the effects of shape, color, movement within individual shots, graphical materials, and film stock materials. A special application of the testing strategy is also used with television performers, actors and on-camera personalities, anchormen, hosts, etc., through the collaboration of various casting agencies associated with television studios and networks. All research in this area is in the form of pre-production assessment of components of a possible program, before the actual program is produced. The testing acts as a research tool for the production team allowing them the ability make more viable choices based on feedback from a sample of their potential audience. This strategy is often applied when producers are presented with severe time constraints or a wide variety of possible choices of potential production elements.

### 1.3 Semantic Testing

Semantic testing covers all biocybernetic probes and tests of plot synopsis, scripts, dialogues, gags, etc., performed during the creation of the script. Testing can also be carried out on preparatory literary materials, novels, stories, poems, musical pieces, etc. A specific part of this testing is done in relation to the potential audience, where certain ideas, values, stereotypes and archetypes are tested before their inclusion into a script by the writer.

### 1.4 Creativity Assessments

The final area of the application of biocybernetic research in television, that of creativity assessment, looks into at the "creativity" of the production team members, prior to their employment in a network or a particular television production. Occasionally various production abilities are assessed during the formation of creative teams, through the direct application of biocybernetic tests on potential personnel, scoping on particular variables associated with the many creative aspects of televison production.

The four applications mentioned above are easily combined and applied on various levels within the television production environment. The choice of a particular area or its application, would depend on the individual production situation and the needs of the team associated with the program and its development. No one area of biocybernetic research, applied in television is in exclusion of another and they should serve as "tools" to the production team.

## 2. FUTURE PERSPECTIVES OF BIOCYBERNETIC RESEARCH IN TELEVISION

There are many new developments and promising areas in the field of applied biocybernetic research in television, such as the following:

2.1 Biotelemetry
2.2 Miniaturization of scanning and recording equipment
2.3 Digital processing of the extracted data
2.4 Computer tomography of the brain (Brain Mapping, CAT, PET)
2.5 Chemospectrography of the brain cortex
2.6 Magnetometry of the brain (MEG)

Within these areas, a number of discoveries have been made in recent years or even months and the field of study (applications) as well as the instrumentation is rapidly changing.

### 2.1 Biotelemetry

Biotelemetry, applied in biocybernetic research, is associated with the development of transceivers that are capable of transmitting physiological signals over distances, (EEG, EKG, and GSR).

Such systems allow for a multitude of research requirements to be met. Each modular system can be expanded from one to eight channels, by simply plugging in additional data channels. Completely portable transmitter units are attatched to the test subject. Each of the modules is powered by a battery, which can operate continuously for up to four days without a recharging.

The signal to noise ratio for each data channel is comparable to a conventional hard wired system and it is relatively interference free because each transmitter is tunable over a frequency band of 174 - 216 MHz. Calibration units are also available for all systems, providing input signals similar in frequency and signal level to the parameter being monitored.

The receiver/demodulator unit for the "Bio-Sentry Telemetry" system, for instance, is a solid-state FM receiver, tunable to the exact frequencies of the transmitter. A multi-antenna system can be utilized to expand the distance over which the monitoring may take place. The receiver outputs are designed to accomodate a high or low input level to the readout unit. The readout unit is plugged into whatever channel is selected. Output can then be fed into a pen driven chart, oscilloscope, tape recorder or combination of tape recorder and scope simultaneously.

The advantages of the biotelemetry units are obvious. It is no longer necessary to have a special testing lab set-up, in a confined space. The test subjects are free to move in any space up to 2.5 km from the transceiver. The scanning units on the subjects are small, portable, and battery driven.

### 2.2 Miniaturization of Biometric equipment

This is a particularly interesting area of development as it allows for innovations in the application of biocybernetic research in the field of communications. New, portable and light transmitters and data recorders have been introduced in the past years. Now it is possible to effectively monitor EEG, EMG, GSR, cardiac, respiratory, and other vital functions in the subject's environment.

Due to the portability of microcomputers designed for the continuous analysis of information, as many as eight physiological sensors may be used for long periods of time. Small, light weight, these sensors can monitor a subjects normal activities in their home and work environments. Since the processed data is stored in solid state memory, it can be

instantly recovered and displayed, by a program such as the Data Manager, used on an Apple II microcomputer.

These small systems can be easily reprogrammed for different applications. A variety of well documented custom programs are offered and users can also develop their own software or even interface their existing sensing equipment.

The newest generation of intelligent microprocessor based systems is small and light weight, with 100% solid state construction. They are extremely reliable and can function is virtually any environment, storing thousands of data points in memory. Battery life of the data collection units can be extended allowing the units to function continuously until the memory is full.

The compactness, reliability and ease of operation of these systems opens new areas of application in biometric research, which up to this point were limited to a laboratory setting, and hard wired bulky equipment set-ups. These technological advances allow the possibilities for research to advance into new frontiers which were previously excluded due to the logistics of the equipment involved.

### 2.3 Digital Processing of Data

Recently the application of microcomputers to the processing of biometric data has allowed researchers greater flexibility and ease in the analysis of their information.

Unlike a tape recorder, the "intelligence" of a microcomputer allows it to perform functions that go far beyond the simple recording of data. A microcomputer based system can confirm the validity of the sensor input, perform mathematical calculations, identify physiological abnormalities as they occur and store the information at selected intervals. These systems are even "smart" enough to stop storing information if the sensors are unplugged.

By using techniques to monitor information input and other data compression techniques to ignore redundant information, the utilization of the memory is held to an optimum. Long recording sessions are possible and there is no huge mountain of data to sift through at the end of the testing session. Paper records are virtually eliminated from the process as all the input information is stored is digital code.

Before a testing session, the researcher can test all the major functions of the monitor unit to be used and ensure the calibration of the sensors. The subject can use a switch activated LED, to visually check that the monitor unit is receiving and storing valid sensor information. This process greatly insures that the testing will be valid and the information received from the subject can be later used in the research results.

At the conclusion of a recording/testing session, the information stored by the unit, is recovered by connecting it to a microcomputer, in this case the Apple II, which uses a program acting as a data manager to interect with the information and manipulate it so that the researcher can retrieve the results in a meaningful way. The data can be numerically or graphically displayed on a video screen and/or printer/plotter configuration, before it is stored permanently on a floppy-disc for further analysis at a later time.

The program for the system allows for the adjustment of the several parameters before the recording session. Sampling rates, number and types of inputs, calibration factors can be set to the appropriate values before the monitor and sensors are applied to the research subject.

After the completed test has been run and the information stored in some form of permanent memory, the task of signal processing can be started. Prior to the application of microcomputers to biometric research, this process was often long and arduous, requiring the examination a large amounts of paper records for each test subject. There were problems with verification of the data, time log correspondence, selection and display of the data, etc. Now all these difficult tasks have been facilitated by computer processing of the digitized data.

The digital signal processing has three levels; starting at the level of signal enhancement, continuing to signal modularisation and ending with the selection of representational signal features. For biometric signal processing, a number of computer programs and software instructional packages have been developed recently. These programs range from simple instructions for a biometric module, to complicated data bases used for the diagnosis of biometric recordings. Many programs are available, and are too numerous to describe here. The software ranges from personal custom designed applications, to commercially available packages. It is possible to design a data acquisition and analysis system to fit virtually any research problem that the investigator wishes to address.

The hardware for such biometric digital data processing techniques is readily available and is currently in use in many areas of communication research. It consists of the following equipment: Data acquisition Unit, Apple II (or comparable) computer with interface card, at least 48K of RAM memory, an external disc drive, a colour monitor for the display of data, and a graphic printer/plotter for a hard copy of the data displays.

It is obvious from the preceeding discussion, that the application of microcomputer technology to biocybernetic communication research has and will continue to open new doors for researchers in television production techniques. Certain areas have been previously avoided for many reasons, particularly the difficulty in the recording and analysis of the test data. The application of information technology will continue to make advances into the field of biocybernetic communication research as both the hardware and the software becomes easier to use and more readily available to researchers.

In looking at the advantages of microcomputer technology in biocybernetic research in application to television, and specifically to television production, we can see enormous opportunities. The research data can be assembled, tabulated and displayed to the television artist in or near real-time, on-line situations. For example, the information impact of a television show in rehearsal can be displayed to the director and switcher during the same rehearsal, allowing them to correct or change dialogue lines, camera shots, lighting or sound arrangements.

A number of variables can be distinguished and displayed to the producer or director at the same time, simply by the flip of a switch or by typing the desired computer code. Such variables could show the artist how his/her show is perceived by members of the audience, of a different sex, cultural background, age or different attitudes.

Another opportunity in computer applications lies in pre-production testing procedures. The daily rushes of location material can be tested quickly and in real-time situations. Graphical, photographical or sound materials can be pretested before their inclusion in a program.

What has in the past amounted to long hours of work for the researcher, is now possible to perform within the range of minutes or seconds and is not influenced by delays in graphical, motoric or verbal display abilities of the audience.

One very special stream of research application that is on the verge of being explored, is the biofeedback use of biocybernetic research in television production. Here, the artist/producer is able to monitor himself and his/her processes of thought without being disturbed by the setbacks of self-awareness of monitoring, and can later react positively to the development of creative climaxes and situations of their own minds. Such monitoring was nearly impossible and bothersome when the traditional psychometric practices were used.

In the past, most television artists were complaining that the simultaneous monitoring and written or verbal recording of their creative processes was diminishing their creativity. In all these application areas however, the audience response data of primary (initial) information impact must be taken into account with great caution, since a number of side effects could influence the stream of thought of either the creator or the television viewers alike.

## 2.4 Computer Tomography of the Brain

The recent modifications of X-Ray technology has led to what is called computerized tomography of the brain or **CT** scan, also called computer assisted tomography, or **CAT** scan. This development has permitted direct, detailed visualization of the soft tissue of the brain. A further advancement of this methodology called "Positron Emmisson Tomography" or **PET** scanning, extends the principles of tomographic scanning to the evaluation of the functioning of the brain. In this technique, the scanner detects the emission of radioactive particles from the brain. As early as 1974, the first PET scanners were used for monitoring of the activity of the neurons in specific areas of the brain.

The Computer Tomography approach has opened doors to the analysis of otherwise crammed or indistinguishable signals obtained by electrophysiological or radiological means. The colour coding of the cerebral cortex responses helps to locate specific areas involved in mental activities. The "cortical maps" are giving us a data base upon which we can develop advanced artificial intelligence units.

In the field of television production, pre and post-production and audience response research, CAT and PET scans are offering the unique opportunity to look at what is happening in the "whole brain".

Electrophysiology, biometric and biotelemetric methodologies are usually measuring a few specific spots on the brain cortex and the diagnosis must then only be a guess at what is happening in the space between or deeper within the human brain's hemispheres. X-raying the human brain sectionally and displaying the sections in a 3D fashion on a video screen allows the researcher to look at brain activity in a more holistic manner, and permits him to follow cortical and subcortical activities. For the first time, we are aware of the so called "marginal activity spheres", which may, by being far from the main information processing centers, influence the final outcome of the memory storage or orchestrated complex information recall. However, CAT and PET scans are not easy procedures. Both scans involve a clinical environment and services of a hospital. The speed of the scanner is slow and the entire

process is relatively tiresome. Considering all the constraints, we are, for the first time, able to look into the semantic structures and skeletons of a television program's impact, something which in the past was reserved exclusively to the psychologic and psychotherapeutic domains.

### 2.5 Chemospectrography of the brain

It has been known form the early 30's, when Otto Loewi performed his classic experiment in the area of chemical neurotransmitters, that the human brain is functioning on a largely chemical basis. In the 60's and 70's Hubel conducted experiments documenting the chemical basis of human memory. But, the decoding of the storage mechanism had to wait until the early 1980's when the first experiments in chemospectrography of the human brain were possible. Chemical processes on the neurotransmitter level are difficult to detect since their timing is unpredictable and the detection requires analysis in vivo, nearly impossible to conduct on living persons.

The major advances in nuclear medicine duing the 70's brought new insight into the field. By injecting a subject with minute amounts of a radioisotope (such as cobalt, thalium or lithium), the time of chemical dispersion and residue can be measured and viewed on a video display or on digital conversion devices. The transmission, retention and decay of the radioisotope particles are related to the chemical processes in the brain.

The combination of radioisotopes, which adhere to certain neurotransmitting substances can then produce a map, which indicates the time and sites of the levels of concentrations in the brain cortex.

In the late 1970's, the team of Lassen, Ingvar and Skinhøj, studied the changes in the amount of blood flowing in areas of the human cerebral cortex, reflecting changes in the activity of those areas, and graphically displayed them, through the aid of a radioactive isotope. In their labs at the Bispebjerg Hospital in Copenhagen and the University of Lund in Sweden, they scanned the subject's head and traced the path of the isotope, (xenon 133), with a battery of 254 externally placed detectors.

The resulting graphical, computer processed displays, mapped areas of activity during different states of information processing.

Such data are important supports for the more standard analysis of electrophysiological signals (EEG), of evoked potentials from the cortex, that are extracted in a greater time, distance from the stimuli, (imagination potentials). In fact, here we are entering the domain of what is called "secondary information space", or a whole group of mental processes associated with memory retention, fixation and storage. Once again, for the first time, we are able to follow over a much longer time period, the formation, fixation and decay of the temporal neural pathway, which is the basis of memory. The isotope life span is measured in hours and days, so we are able to trace the memory residua of a television show within the hours or days following the reception of the televised program. Also, when certain recalls of information are made, we are able to detect the process of recall or the imagination portion of this recall, which the viewer is adding to the previously perceived show, from his or her own memory.

### 2.6 Magnetometry of the brain

The latest development in biocybernetic research, is the measurement of the brain's magnetic field. Study of the brain cells' collective electrical activity has relied heavily on computer-based techniques. One of the most important advances has been the mapping of the brain's electromagnetic fields at high spatial resolution, with scalp electrodes.

Another promising approach is to map the magnetic rather than the electrical component of the fields. Even though the brain's magnetic fields are only about a billionth the strength of the earth's magnetic field, a scanner known as a superconducting quantum interference device or **SQUID**, is sensitive enough to measure them effectively. The basis of this technology lies in two magnetic coils, supercooled to 4 degrees Kelvin, (-453 F.) The team of Lloyd Kaufman and Samuel Williamson at New York University, among others working in the field, have used a SQUID to map the EEG of human subjects with great accuracy.

Due to the fact that the brain and the skull are transparent to magnetic fields, high resolutions can be obtained at the surface of the head. The NYU team claims that magnetic sources can be traced to within a few tenths of a millimeter.

As more detailed and higher resolution maps are developed, it may be possible to begin to distinguish between phenomena associated with the highly variable small-scale fields and those associated with the more coherent whole-brain fields. One hypothesis that has been put forth is that the small-scale variations are closely tied to sensations (the brain's map of the external world), while the whole-brain potentials are linked to the brain's inner processes, (the monologue that goes on inside our heads).

A system for visualizing brain waves, known as the Brain Electrical Activity Mapping machine, or BEAM, was developed by Frank H. Duffy and his colleagues at the Children's Hospital Medical Center in Boston. The **BEAM** machine, converts the EEG data from a 20 electrode array on the scalp, into a multicolour map of brain-wave activity, through applied computer enhancement techniques.

Another method used to map the brain by measuring the magnetic field, is called magnetoencephalography or **MEG**. Unlike the electroencephalogram, (EEG) techniques, which require the placement of electrodes inside or outside the cerebral cortex for the measurement of electrical signals, MEG measures the minute magnetic fields associated with those signals in a noninvasive manner. Further more, MEG can be used to pinpoint the location of neural firings, something the EEGs cannot do. Larger systems of the MEG are planned, using a 100 channel system, sufficient to completely encircle the head with a closed space grid.

Magnetometry of the human brain presents an uncharted and exciting opportunity for the television audience researcher. With this tool, we could "forecast" if or how a television show will be perceived by the viewer. A magnetometric map of the brain is a mental tool for script writers, program developers and audience research or advertising agencies, with which, the audio-visual stimuli could be planned in the most effective design. The numerical data or graphical model is giving the

creative person limitless opportunities in the design of plots, show information skeletons, situations and characters. On the other hand, it could also warn artists against plots or characters which will be perceived negatively or rejected by the audience.

These and many other forth coming developments in neuromagnetometry are offering a large possibility to extract data pertinent to research into the secondary information space impact. The future of biocybernetic communication research lies in the recent developments in computer applications to the processing and storage of data, the miniaturization and portability of equipment, and advances in detailed scanning techniques of the human brain.

### 3. CONCLUSION

The technology lies in waiting. It will be up to those researchers involved in biocybernetic research to find innovative ways to apply both the new technologies and research methods in order to solve problems and questions in the field of television research. More active cooperation must develop between television researchers, networks, production centers and institutions where much of this expensive equipment is now housed.

In the next years, academic researchers will have increasing need to access the technology to apply in their research. The producers of television programs will seek to increase their collaboration with those actively involved in new television research strategies within the university environment. Workshop and seminar situations conducted on a developing basis between the television industry and the academic world, can substantially bridge the gap that exists between "television research theory" and "television practice".

Through a better understanding of the process of human information processing, we can become more effective communicators and media creators. Biocybernetic communication research applied to the medium of television, seeks to help that direction.

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